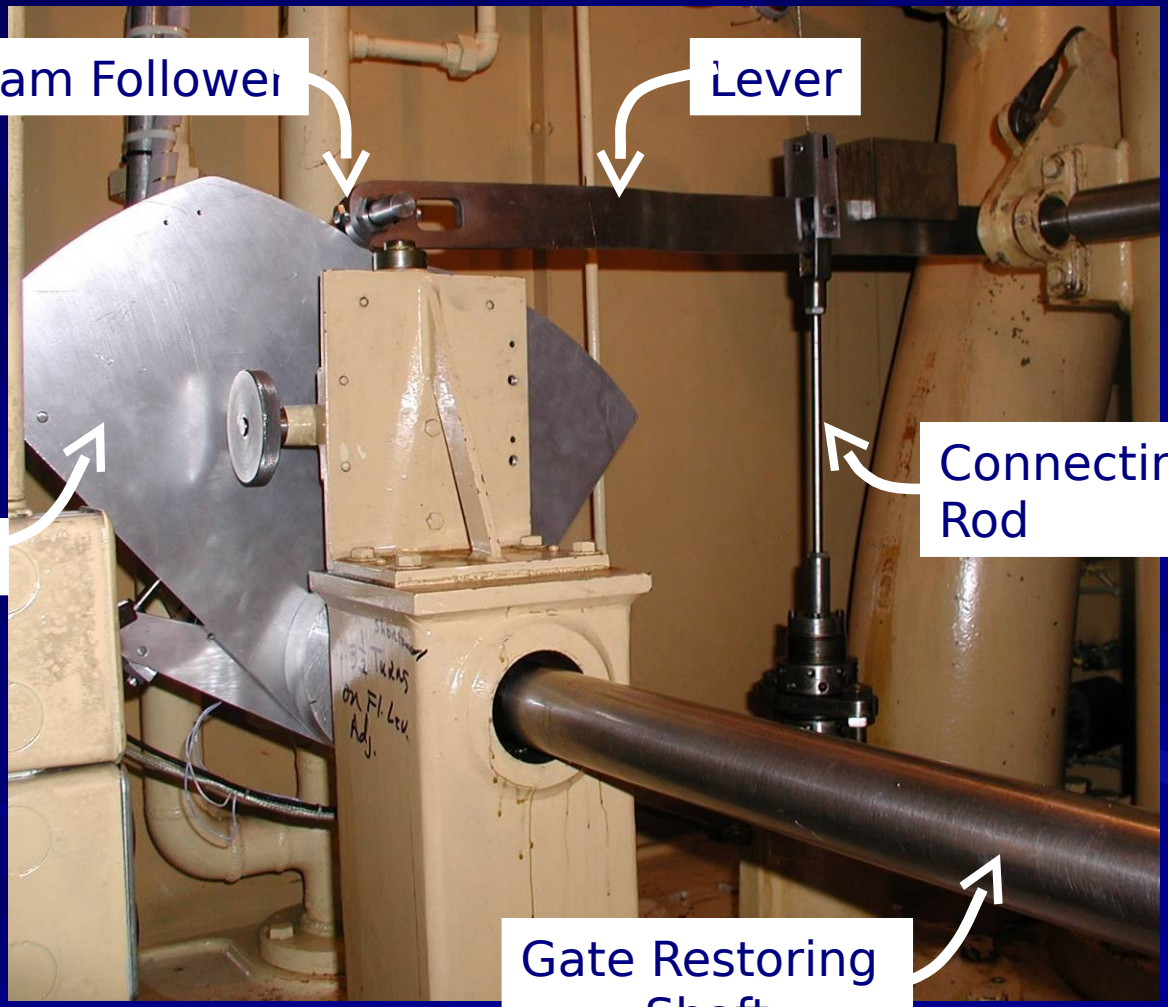
3D Cam Controllers

BACKGROUND:

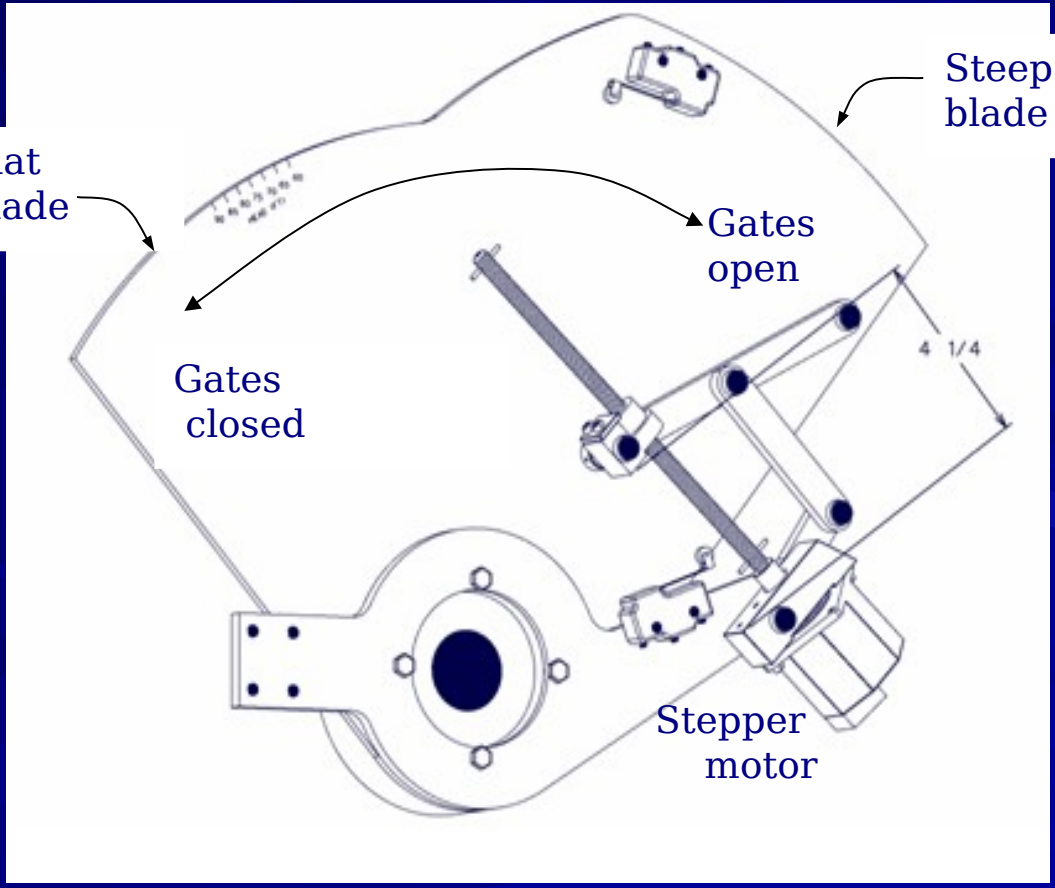
- Mechanical Governors
  - Original equipment installed 1950s (McN) -1980s (B2)
  - Blade position follows gate position
    - Based on shape of hard cam (cam plate)
    - Hard cam valid only for single head
    - Blade position dependent on gate position

Mechanical Governor

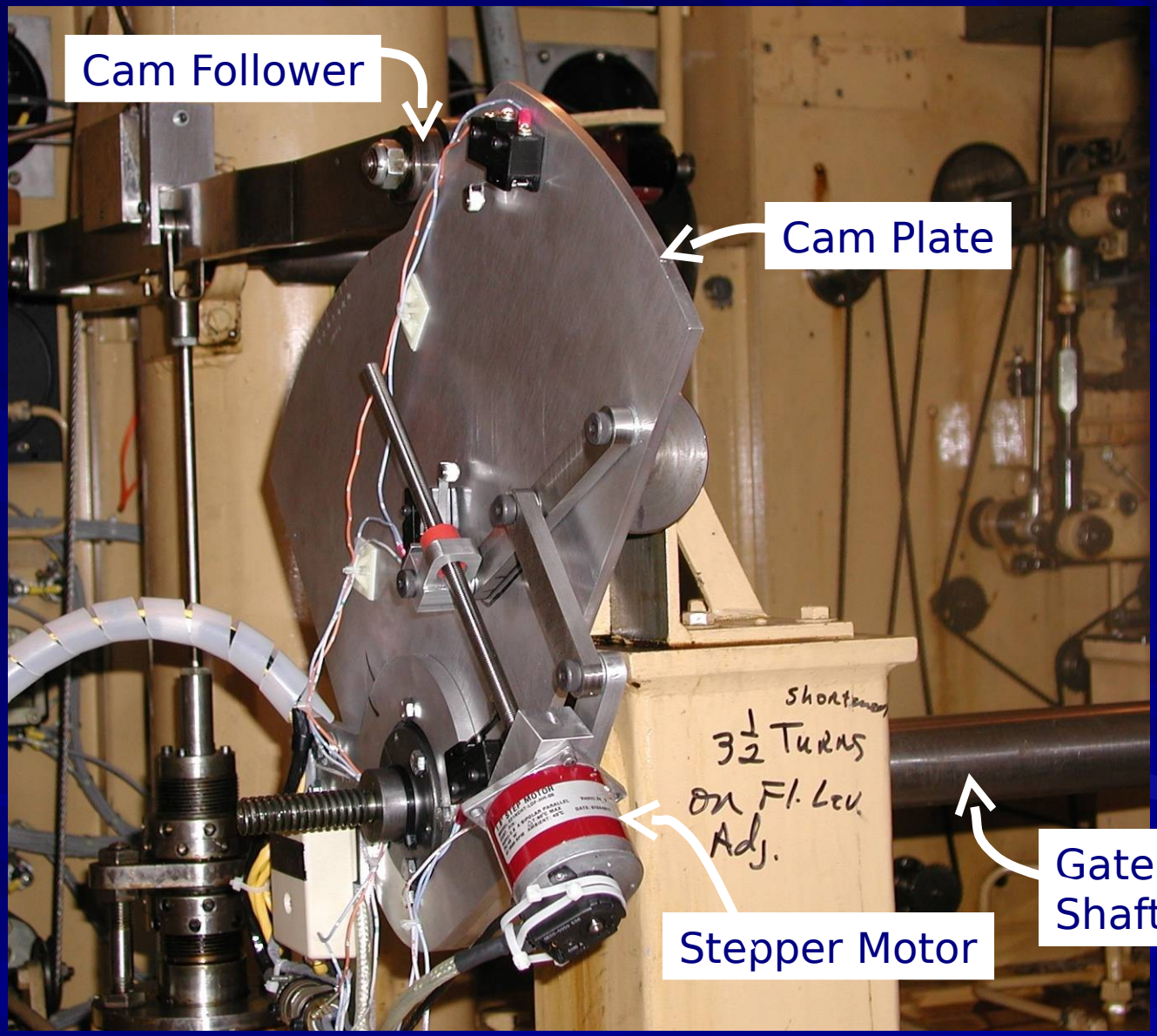


3D Cam Controllers

- Add-on retrofitted to existing Mechanical Governors
  - Originally installed late ‘80s - early 90’s. Newer version installed 2001 to ~2006 (NWW).
  - Stepper Motor used to rotate cam plate & “fine tune” blade position
  - Provides limited range of blade positioning independent of gate



3D Cam Controllers



3D Cam Controllers

- Target Blade position a “look-up” value from Cam Table
  - Based head & gate position
  - Cam Table covers all operating heads
  - Cam Table developed from Index Testing
- Index Testing one unit of every family (Lower Columbia & Lower Snake) to develop:
  - Cam table (optimum gate - blade relationships)
  - 1 % Operating limits
  - Discharge Tables
- Testing begun in FY00, completed FY06.
- Latest tables installed at all projects & GDACS

3D Cam Controllers

- As of 2006
  - New versions of 3D cam controllers in-place (NWW)
  - Updated Tables in-place (all Projects)
- Are 3D cams functioning as intended?
  - Operational Surveys conducted annually (beginning in ’05)
    - “Snapshot” surveys
    - Limited number of issues identified
  - Expanded Surveys conducted Fall ’07 & Mar ‘08
    - Archived GDACS data used to better evaluate 3D cam operation
    - Indentified frequency that 3D Cam Controllers were non-functional (unit by unit evaluation)

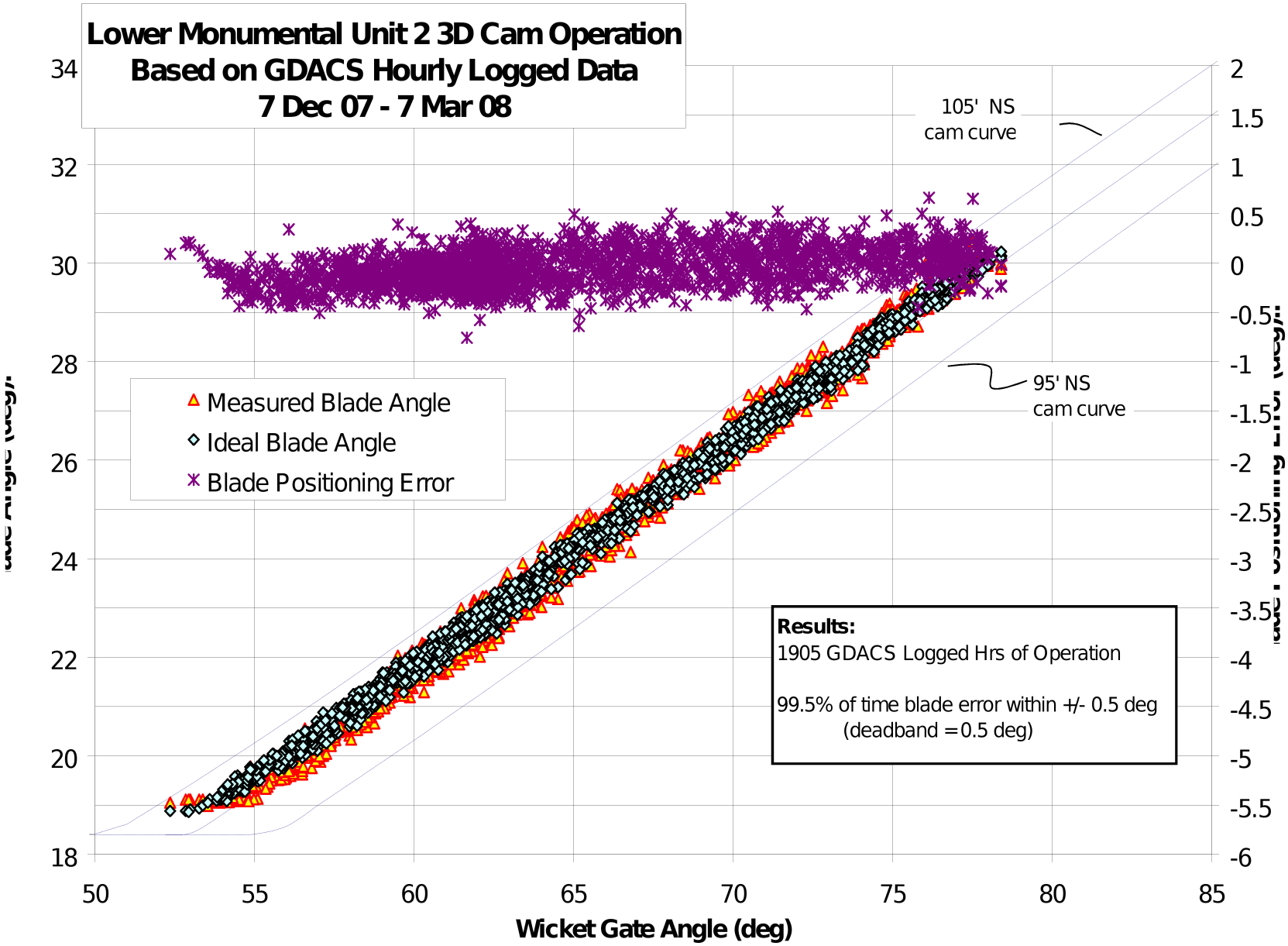
3D Cam Controller Survey Results

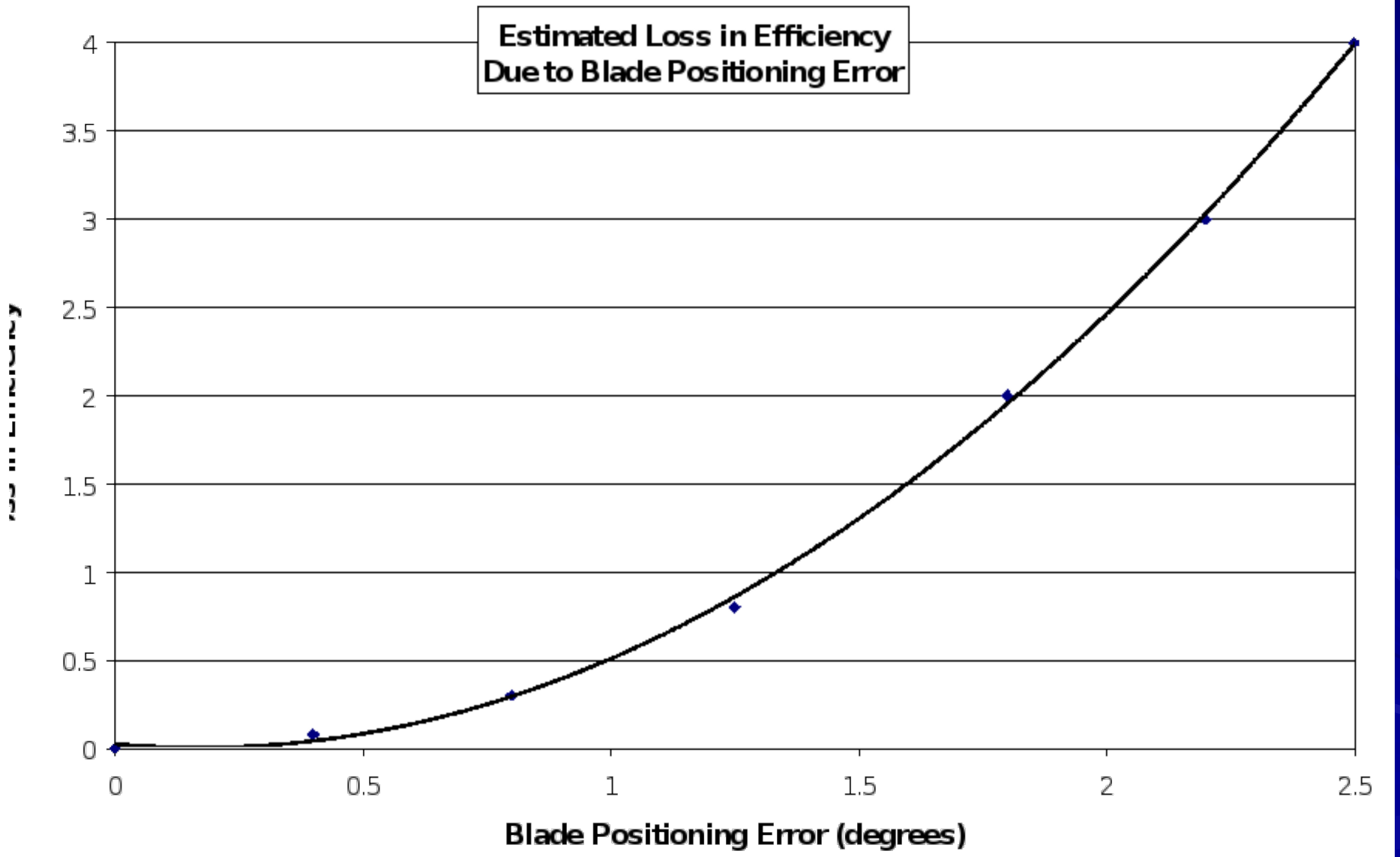
- LMN and LWG:
  - 3D cam controller functioning as intended vast majority of time (+/- 0.5 deg blade positioning error)

	Lower Monumental		Lower Granite	
	Sept '07	Mar '08	Sept '07	Mar '08
Unit 1	n/a	n/a	98.9%	94.8%
Unit 2	62.5%	99.5%	OOS	OOS
Unit 3	99.7%	99.5%	100.0%	92.0%
Unit 4	100.0%	98.9%	100.0%	98.8%
Unit 5	99.7%	99.8%	97.3%	99.1%
Unit 6	100.0%	100.0%	100.0%	97.3%

NOTE: LMN U2 low percentages Sept 07 due to stepper motor assembly binding (assembly since replaced)

3D Cam Controller Survey Results




Estimated Loss in Efficiency
Due to Blade Positioning Error
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
Blade Positioning Error (degrees)

3D Cam Controller Survey Results

- McN:
  - Varied results

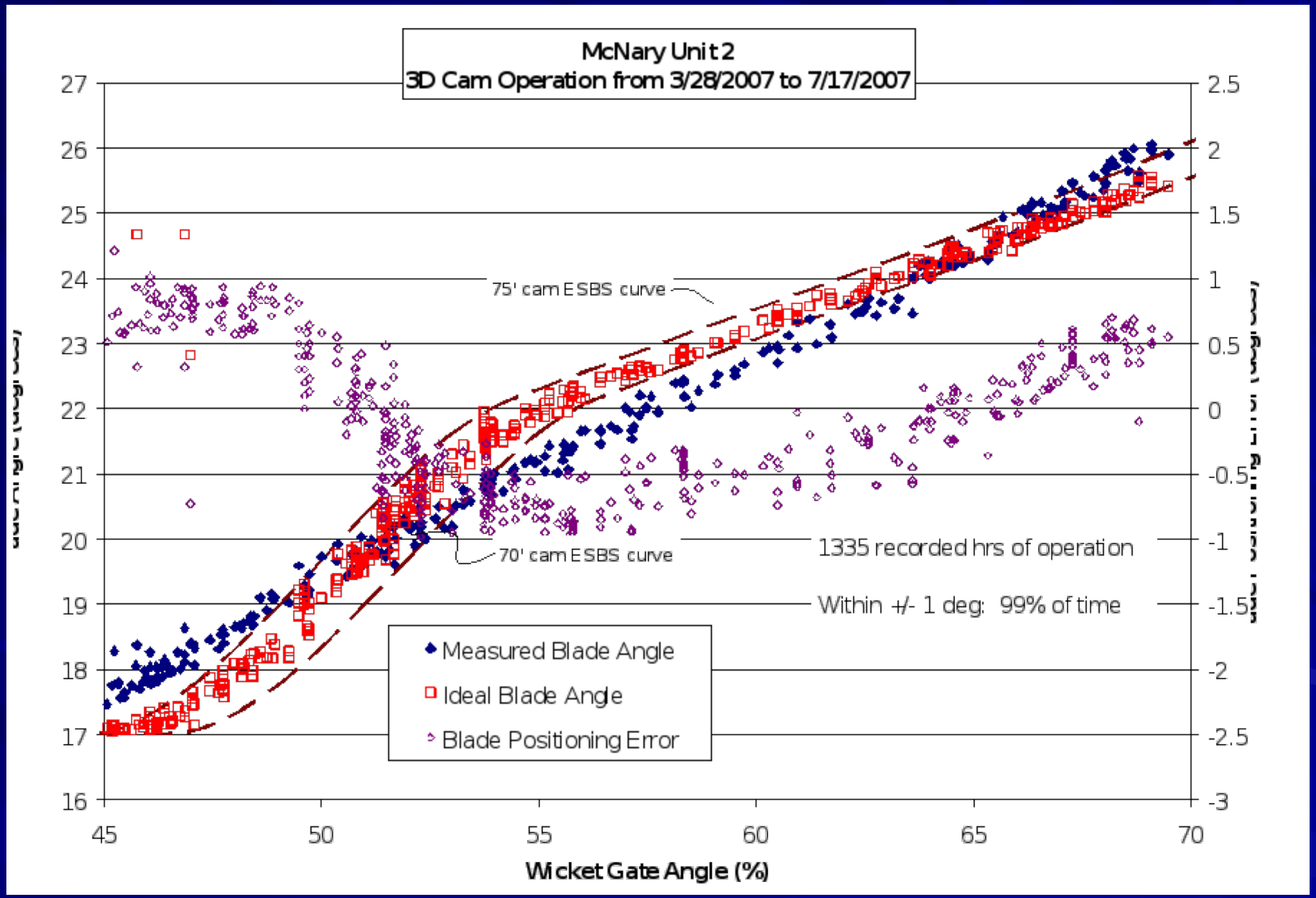
	Aug '08		Mar '08 (prelim)	
	+/- 0.5 deg	+/- 1.0 deg	+/- 0.5 deg	+/- 1.0 deg
Unit 1	99%	100%	86%	99%
Unit 2	41%	99%	92%	96%
Unit 3	51%	100%	82%	99%
Unit 4	89%	93%	82%	94%
Unit 5	60%	98%	93%	97%
Unit 6	60%	94%	89%	98%
Unit 7	60%	99%	75%	88%
Unit 8	51%	100%	93%	99%
Unit 9	93%	95%	83%	90%
Unit 10	51%	100%	86%	96%
Unit 11	40%	70%	93%	99%
Unit 12	41%	66%	92%	98%
Unit 13	30%	60%	75%	98%
Unit 14	35%	60%	86%	94%

3D Cam Controller Survey Results

- McN Aug 08 Surveys identified 3 areas affecting 3D cam operation:
  - Excessive deadbands on Units 2,3, 5-8, 10-14
  - Faulty head indication to Units 11-14
  - Binding of string mechanisms causing blade transducer faults

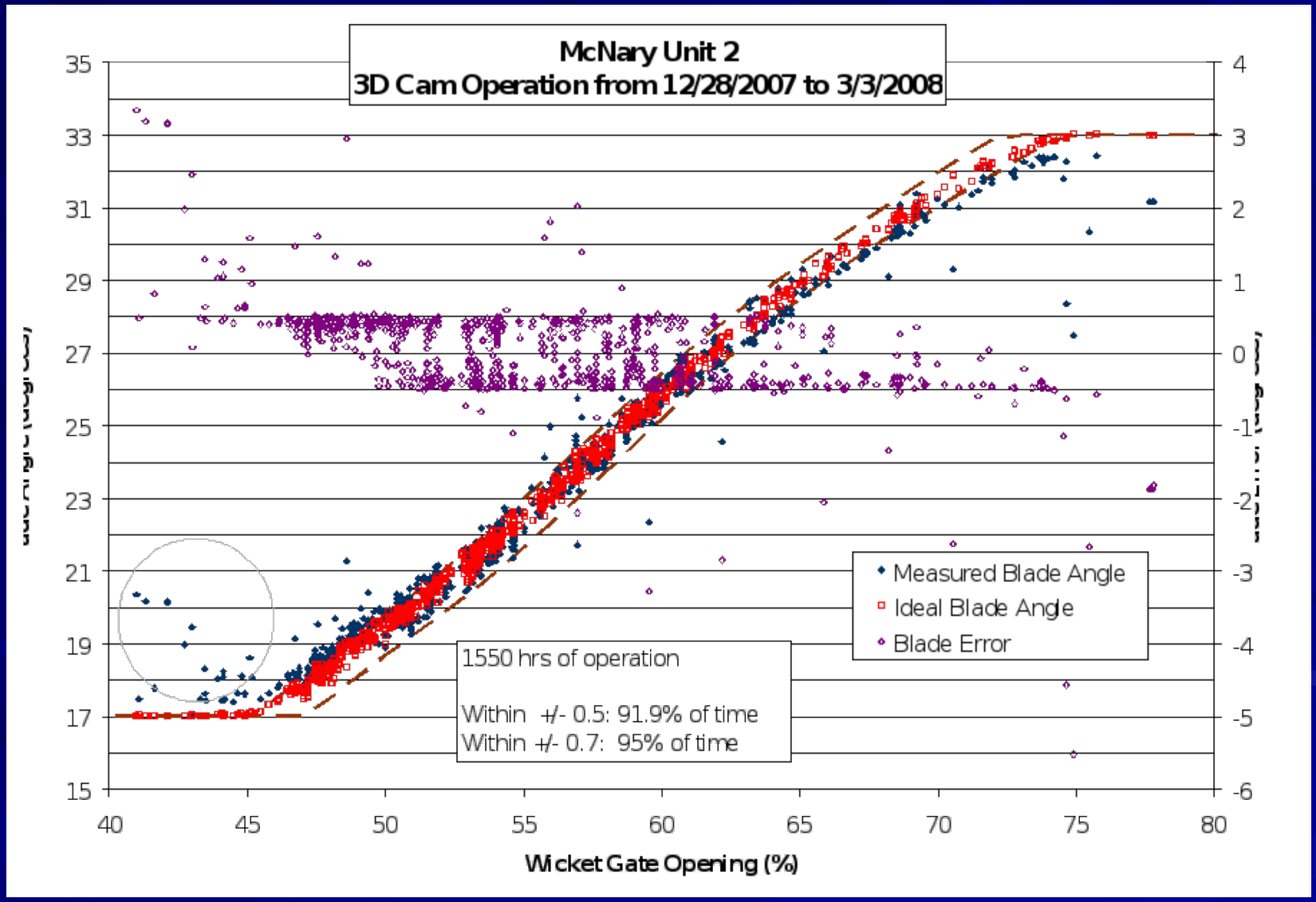
3D Cam Controller Survey Results

- McN: Excessive deadband (+/- 1 deg)



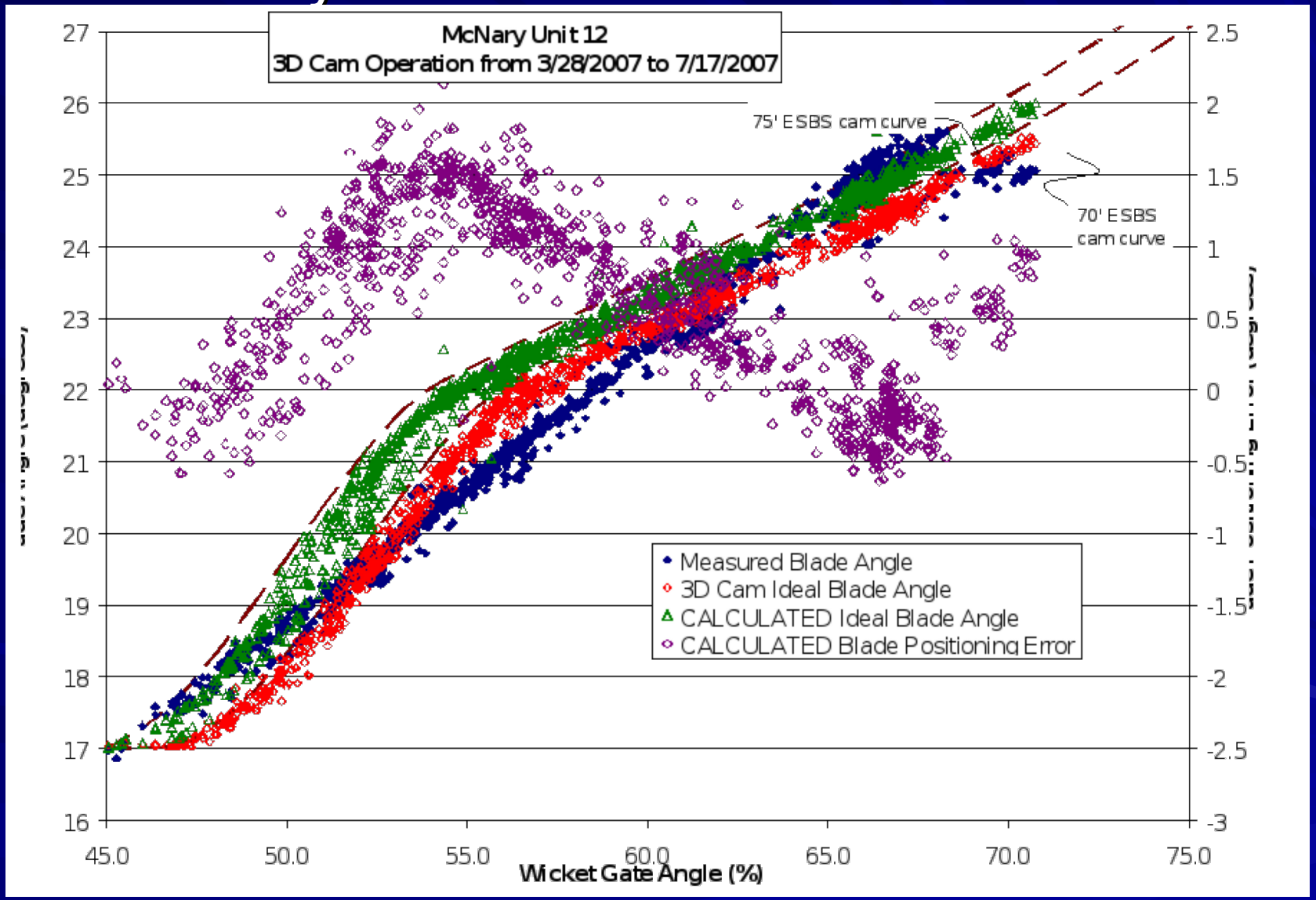
3D Cam Controller Survey Results

- McN: Deadband reduced (+/- 0.5 deg)



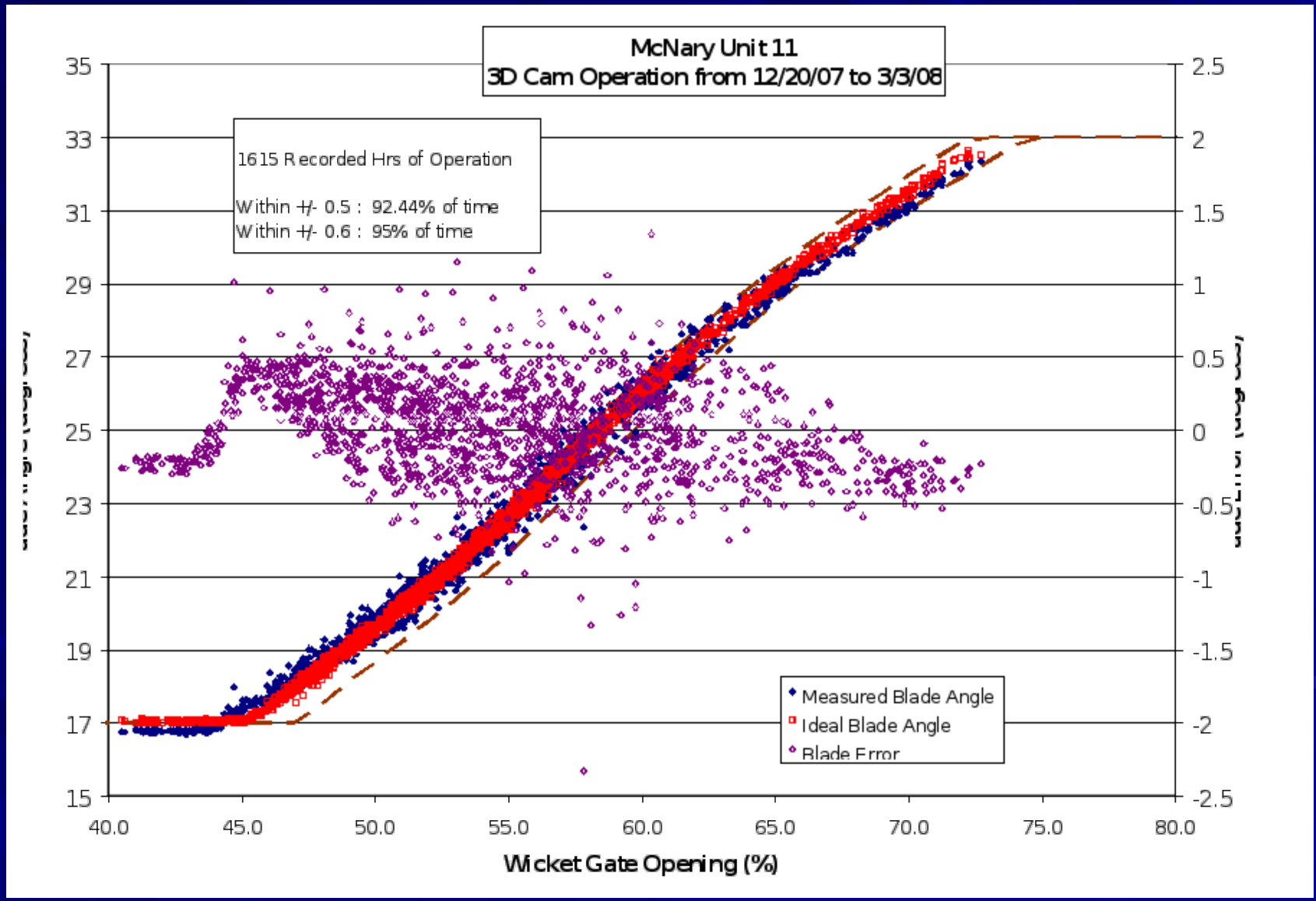
3D Cam Controller Survey Results

- McN: Faulty head indication Units 11-14



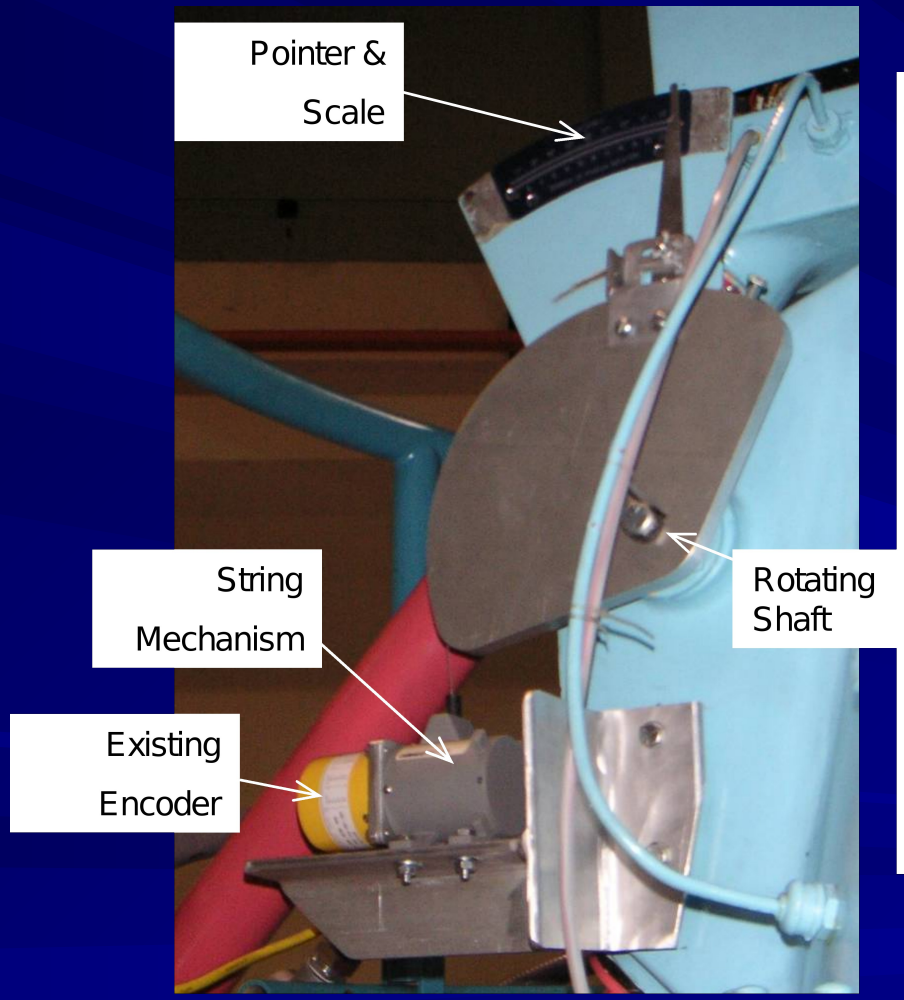
3D Cam Controller Survey Results

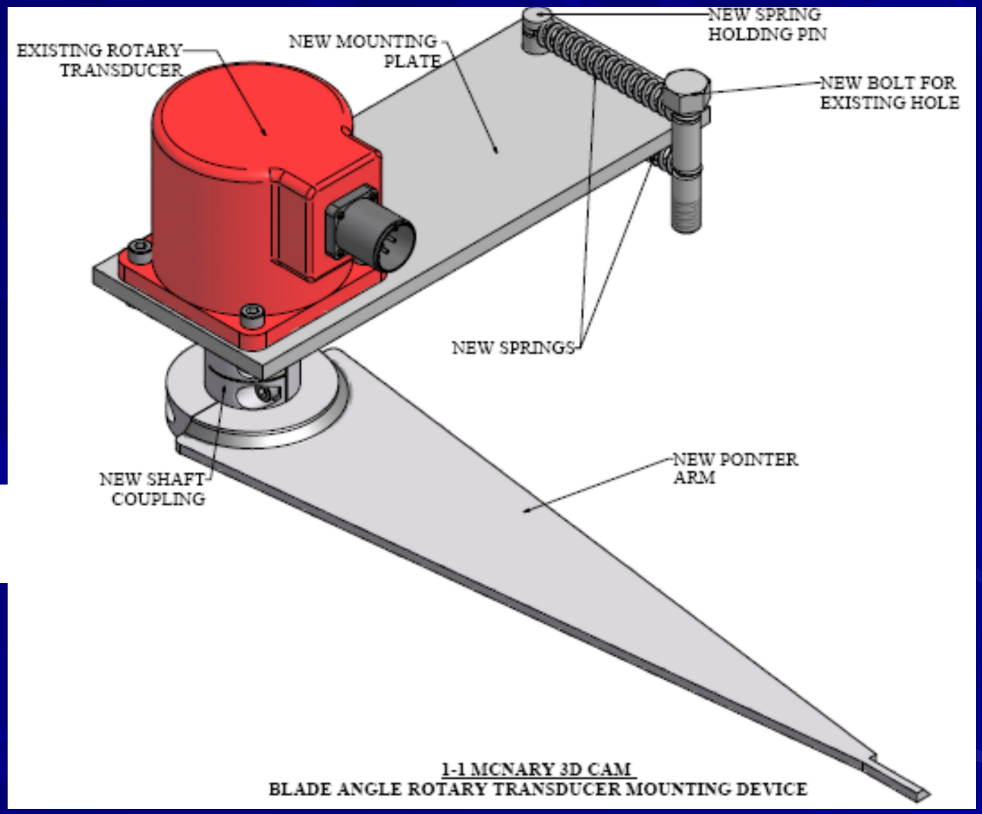
- McN: Failed pressure x-ducer replaced by Project personnel



3D Cam Controller Survey Results

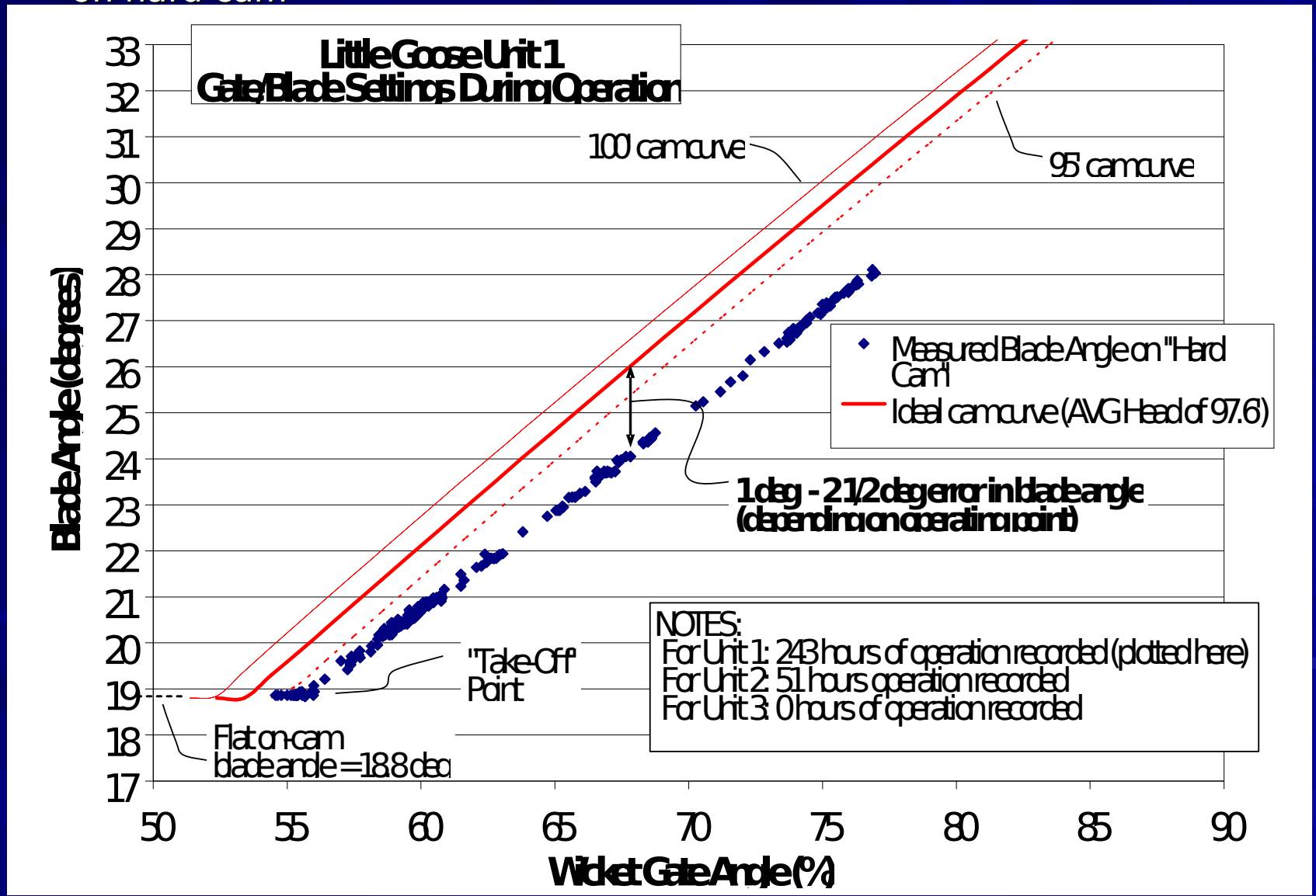
- McN: Design for OH transducer mounting modification sent to Project 21 Feb





3D Cam Controller Survey Results

- LGO Sept 07 Survey: Limited data available.
  - Extended operation without 3D cam functional – operation on hard cam



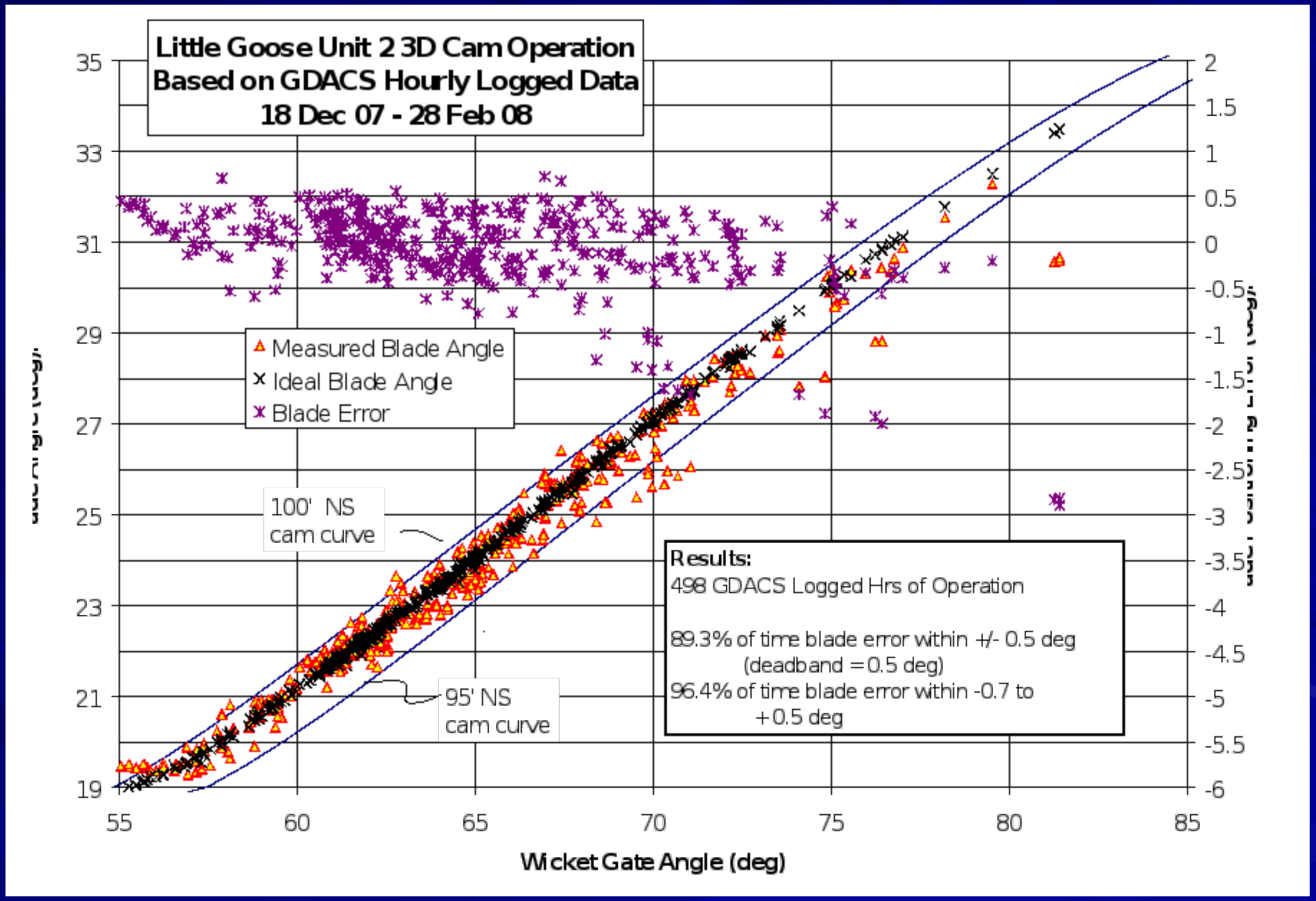
3D Cam Controller Survey Results

- LGO:
  - GMT travelled to site 17 Dec 3D cam programming restored.

	Mar '08
	+/- 0.5 deg
Unit 1	62%
Unit 2	89%
Unit 3	82%
Unit 4	96%
Unit 5	97%
Unit 6	OOS

3D Cam Controller Survey Results

- LGO Mar 08 Survey:



3D Cam Controller Survey Results

- IH:
  - Dec ’07 Survey indicated frequent faults.
  - Project has been troubleshooting. Potential hardware modifications implemented.

	Mar '08
	+/- 0.5 deg
Unit 1	90%
Unit 2	n/a
Unit 3	n/a
Unit 4	93%
Unit 5	77%
Unit 6	OOS

3D Cam controllers

- NWW Surveys to be repeated mid-summer
- What about NWP?
  - 3D cams info not logged into GDACS
  - Cannot perform similar evaluation of operation
  - Annual surveys limited to “snap shot”
  - Surveys have not identified any significant issues

3D Cam Controllers

- Considerable Improvement from Fall ’07
- Continue to work on improving reliability
- Continue surveys to ensure we don’t veer off track